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Sense Making – Underpinning Concepts and Relation to Military Decision-making

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Abstract

Decision makers at all echelons go through a process of goal-directed *sense making* when dealing with complex and dynamic problems involving, for instance, ambiguous or poor information, changing circumstances and multiple players. In this paper we argue that the key to sense making is understanding the nature of and the nexus between the *knowledge* that humans bring to the process and the *way* in which that knowledge is applied in a creative thinking framework to build meaning and to provide judgements, insights and conclusions. In this respect, there are three main concepts in this paper:

- *Knowledge* as a cognitive process that is key to sense making;
- *Philosophy* and *epistemology* as a framework in which knowledge is applied, refuted, tested and grown;
- The recognition that sense making deals with *complex systems* underpins new ways of perceiving the world and generating conjectures that can be tested within an epistemological framework.

The relationship between sense making and decision-making for military operations is illustrated with respect to two decision-making doctrines – OODA and the newly proposed CECA (Critique-Explore-Compare-Adapt). The ideas in this paper resonate more with CECA than OODA, and could be further developed in an experimental environment that looks at different sense and decision-making approaches.

1. Introduction

In the emerging operational environment of network-enabled forces, effects based operations and multidimensional manoeuvre, the nature of the demands levied upon decision-makers has changed. For the joint force commander there will be a greater expectation for an effects-based capability characterised by improved insight and actionability, and reduced latency.

Decision-making in this environment can be contrasted with that required for the more sequential, deliberate campaigns of the 20th century. Interpretation and cognition will be collaborative rather than isolated, involve many distributed actors compared to a few centralized ones, and rely more on self-synchronization rather than command direction. The range and nature of offensive options available to Commanders is also increasing, along with a move away from influence based on attrition and destruction towards those supported by focused effects.

Decision makers at all echelons go through a process of goal-directed *sense making* when dealing with complex and dynamic problems involving, for instance, ambiguous or poor information, changing circumstances and multiple players. The effective conduct of Command and Control warfare, for instance, makes selective use of techniques such as military deception and psychological operations that are inherently complex and uncertain. More generally, a Commander's intent, his understanding of

courses of action and their potential effects, are all the products of a sense making activity. Articulation of that intent to allies and subordinate Commanders increasingly requires an ability to be able to communicate the working matter – the assumptions, guesses, conjectures and facts - of the sense making process as well as its products. This is particularly important for the ADF, as Mission Command (or directive control) has been identified as the future for Australian C2 (ADFWC 2003). It is based on the capacity for a Commander to communicate intent through the chain of command, allowing the subordinates to find their own ways to achieve that intent. Awareness of the rationale behind decisions also allows greater opportunity to respond to unforseen threats or fleeting opportunities.

The focus of sense making is to provide the decision-maker with a plausible understanding of a complex environment of serendipitous and not fully understood interactions and relationships. As outlined in this paper, sense making is a high level cognitive process that encompasses many of the more mechanistic (though not necessarily simple) processes that make up a military operation, such as those involved in the provision of movement and supplies, the categorisation and interpretation of data, or determination of orders of battle.

In this paper we argue that the key to sense making is understanding the nature of and the nexus between the *knowledge* that humans bring to the process and the *way* in which that knowledge is applied in a creative thinking framework to build meaning and to provide judgements, insights and conclusions. In this respect, there are three main concepts in this paper:

- *Knowledge development* as a cognitive process that is key to sense making;
- *Philosophy* and *epistemology* as a framework in which knowledge is applied, refuted, tested and grown;
- The recognition that sense making deals with *complex systems* underpins new ways of perceiving the world and generating conjectures that can be tested within an epistemological framework.

A previous paper has explored the implications of these concepts as applied to sense making for the ADF intelligence enterprise (Burnett 2004). They apply to both policy makers within an increasingly chaotic and unpredictable international security environment, and commanders in a networked military operational environment. It is on the latter domain that we mainly focus in this paper.

2. Sense Making

The concept, at its simplest, is "making of sense". It can be seen from many perspectives, such as structuring the unknown, explaining surprises, or the interaction of information seeking, meaning ascription and associated responses, or the framing of problems and issues from a problematic situation. (O'Connell 1998).

Sense making and situation awareness (SA) are closely linked. One of the more general and widely agreed upon definitions of SA is that it is “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future“ (Endsley 1995). We’ve used the term sense making rather than situation awareness in this paper to

abstract away from the temporal and physical associations of the word "situation". SA is often discussed in terms of fighter pilots or air traffic controllers making quick decisions in complex situations, where awareness relates to a definite physical reality and where decisions need to be made in real time. Sense making is both retrospective and prospective and is a process (rather than a state) that involves realities that are often constructed purely in the minds of the participants. In this regard, Weick (Weick 1995) likens sense making to cartography:

> "There is some terrain the mapmakers want to represent, and they use various modes of representation to make this representation. What they map depends on where they look, how they look, what they want to represent and their tools of representation…. The crucial point in cartography is that "there is no 'One Best Map' of a particular terrain…. The terrain is not already mapped so that the job of the sensemaker is to discover the preexisting map….. It is the job of the sensemaker to convert a world of experience into an intelligible world. That person's job is not to look for the one true picture that corresponds to a pre-existing, preformed reality… there are only maps that we construct to make sense of the welter of our experience."

The complexity, uncertainty and dynamism in sense making for commanders of military operations can be illustrated with reference to a modified chess game. In this hypothetical game, each commander (player) is advised by a large number of supporting staff with more or less well-defined roles, each side sees different portions of the board, pieces may be playing their own game in response to local circumstances, the rules of the game are not clear and may be different for each player, and the winner of the game is not always obvious and may be decided by a completely independent group of people many months or years later!

In dealing with multi-faceted and complex issues intelligence analysts have always been challenged in providing sound and timely advice. This has increased in difficulty and changed in nature since the end of the Cold War where intelligence knew the problem and could envisage a reality it was seeking to comprehend. A similar paradigm shift is required for decision makers dealing with a more challenging reality that is fundamentally complex, uncertain, and in some cases unknowable[1]. The change in this view of the world is explored more in the next section.

3. Sense Making, Knowledge, Philosophy And Complexity

A key to sense making is attempting to understand the nature of the knowledge that humans bring to the process, and the way in which that knowledge is used, shared, tested and evolved during the process. How sense making occurs, and how knowledge

[1] There is a critical distinction between what may be called *conventional* threats and *emerging* threats. [ref: Robert Steele, On Intelligence – Spies and Secrecy in an Open World, OSS, 2001, quoting from Gen Alfred Gray, Commandant of the Marine Corps., Global Intelligence Challenges in the 1990's, American Intelligence Journal 1989-1990] Conventional threats are associated with static orders of battle, linear development and deployment capabilities, and well-understood rules of engagement and doctrine. The emerging threat, in contrast, is non-governmental, non-conventional, dynamic or random, non-linear with no constraints or predictable doctrine.

is used, is strongly dependent on how we think and how we understand the world. This is the territory of philosophy and epistemology, and constitutes a framework or methodology in which knowledge can be used. And while philosophical models may seem irrelevant they are important and are underpinned by, and intertwined with, our understanding of the world. In this context, Reid and Giffin (Reid and Giffin 2003) note that:

> Uncertainty is fundamental in nature, rather than just a residual insufficiency of information. Truth is not buried in the data, information does not bring about knowledge, and the best answer is not normally within reach even in principle.

3.1 What is Knowledge?

How knowledge is defined determines how it is managed, so it is important to have a clear definition. And the terms knowledge and information are so broad that they become meaningless unless given clear definition. For the purposes of exploring the role that knowledge plays in sense making we adopt the following definition:

> Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Davenport and Prusak 1997).

This definition ties knowledge closely to cognition and argues that knowledge is a dynamic, conceptual and largely human process of organising, re-organising and of making sense of information, experiences, and events (Nitecki 1985). In this view, knowledge is not a "thing" or a system, but an ephemeral, *active cognitive process of relating* (Stacey 1992) the external world and external events to what is already known.

Within a predominantly Popperian philosophical approach, Reid and Giffin (Reid and Giffin 2003) see knowledge of a phenomenon as any set of theories that attempt to explain that phenomenon. Information is seen as messages that have the potential to impact, alter or refute the knowledge held by an individual or group. This makes knowledge fundamentally very different to information (and data) (Hayes 1993).

Some knowledge can be made explicit, and codified as information. A key characteristic of this type of knowledge is that it can be disembodied from its knower or originator. Since knowledge encoded as information can be disembodied from its creator, it can be shared as words, pictures, as e-mails, web pages, text guides, instruction manuals, and so on, and can be held in forms that can be duplicated, shared, or stored in a computer system. Managing this kind of explicit knowledge is the realm of information management methods and information management technology.

In contrast to explicit knowledge, *tacit* knowledge is the intangible, internal, and intuitive knowledge in the human mind. By its very nature, it is very difficult to make tacit knowledge explicit (Polanyi 1966). Tacit knowledge has to do with insight,

understanding, experience, capability, skill and expertise. This kind of knowledge can be shared through an on going interaction between the holder (the knower) and the receiver of the knowledge.

One of the great myths of knowledge management is that knowledge of this type can be readily converted into information, and is thus open to exploitation by information management techniques. By definition, however tacit knowledge cannot be converted directly to explicit. (McDermott 1999).

As well as being what we know, knowledge also acts as a framework for evaluating and incorporating new experiences and information (Davenport and Prusak 1997). In essence, we use our existing knowledge to create our new knowledge. New events, experiences, and information are filtered through the results of past thinking, patterns of interpretation, implicit assumptions, and beliefs that have been learnt and built from experience, past thinking and reflection. (Snowden 2002). This relationship between knowledge and sense making is displayed in Figure 1.

It is critical to recognise that the knowledge important to the decision maker engaged in sense making - the expertise, insight, experiences, and judgement of that person and his staff - cannot be easily codified, and cannot be shared as information. As a consequence, the key to making that knowledge more productive is to provide a sound methodology for thinking and to place greater emphasis on the relationships and networks between staff to enable knowledge to grow, be tested and used most effectively.

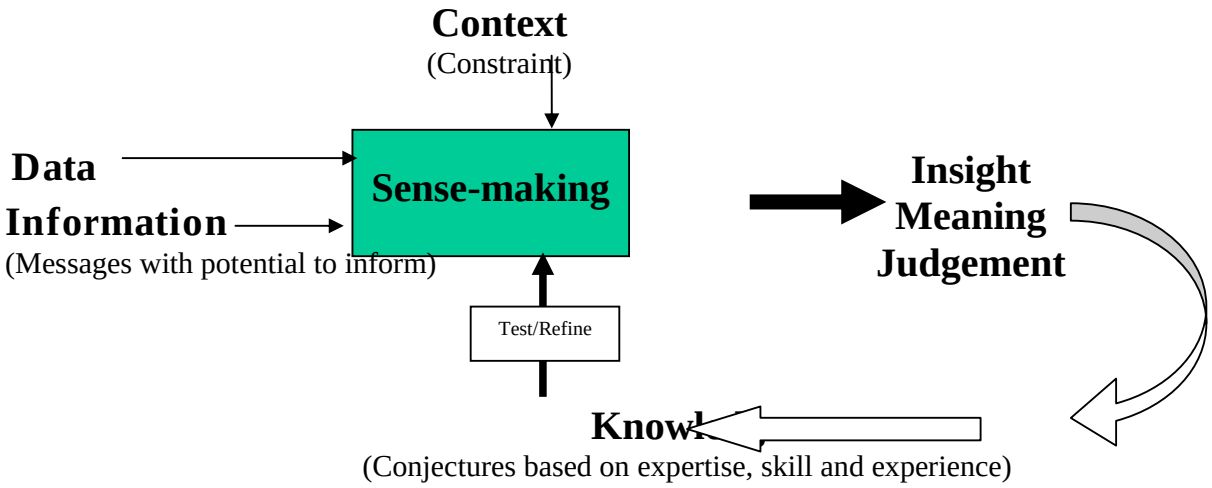

Figure 1:Sense Making and Knowledge.

3.2 Epistemological Viewpoints

How knowledge is applied in sense making depends crucially on its philosophical and epistemological foundations. Far from being a purely academic concept, we follow Giffin and Reid (Giffin and Reid 2003 (I) Giffin and Reid 2003 (II); Reid and Giffin

2003) in the belief that the methodological underpinnings of thinking are crucial to how the process is carried out. Our mental models of the world strongly influence how we try to make sense of it.

There are a number of competing philosophies of truth in use in the business world and amongst military thinkers. In the business sphere (Firestone and McElroy 2003) identify two main philosophical streams called Justificationism and Criticalism at work in knowledge management. Justificationist approaches, while rejecting the idea of truth with certainty, tend to rely on appeals to authority as the basis of organisational knowledge, while Criticalism has a more pronounced fallibilist[2] ethic that rewards testing and evaluation of knowledge claims.

In addressing the core question of "What is the process by which human knowledge grows?" Reid and Giffin (Giffin and Reid 2003; Giffin and Reid 2003; Reid and Giffin 2003) and (Giffin 2002) have identified an Inductivist[3] approach in many areas of military doctrine and thinking, including the tenets underpinning NCW. In answering that question, they argue that the relevant domain is philosophy, and the most robust and constructive approach for military processes, built on Popper, is called Critical Rationalism.

In The Logic of Scientific Discovery (Popper 2002) Popper lays the foundations of a scientific approach to thinking called Critical Rationalism (CR). CR is built upon the idea that the world does not create our understanding, but that we create our understanding. In this view, our outlook on the world is coloured and influenced by what we already know, and by how we choose to see the world[4]. From a sense making perspective this seems a useful philosophy, and coheres with our view of knowledge introduced in Section 3.1 as an active, cognitive process of relating.

CR also rejects the inductive notion that universal theories can be derived from gathered facts. For Popper "All knowledge remains conjectural". Truth, understanding, and development of scientific thought then, is a process of constant refinement of a collection of unjustified anticipations, by guesses, by tentative solutions or problems, and by conjectures. Key to CR is the notion that scientific theories can never be proven, merely tested and corroborated. In essence, falsificationism is the best (perhaps the only) approach to practicing science and knowledge development[5].

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[2] Fallibilism is a viewpoint that sees all human knowledge as irreparable fallible and incapable of being proven or shown to be certain.

[3] The study of natural phenomenon by simple observation, without specific questions or hypotheses. An inductivist approach is to collect lots of data on a subject, look for patterns in the data, and draw general conclusions based on those patterns.

[4] Critical Rationalism has the following key points:
It is an open, problem-solving inquiry processes.
The emphasis is on the creation of testable statements, experimentation and refutation.
The logic of inquiry compels a deduction and evaluation of consequences of theory and action.
Critical rationalism argues for the realisation of the fallibility of knowledge including that of science.
It recognizes the uniqueness of events in a complex and uncertain world and our inability to be predictive.
It has a faith in the notion of objectivity.

[5] "... science grows, and may even approach the truth, not by amassing supporting evidence, but through an unending cycle of problems, tentative solutions – unjustified *conjectures* – and error

Following Reid and Giffin, we argue that CR provides a key point of difference to present emphasis on Inductivism, and a robust approach to reasoning and thinking that is readily adaptable to military purposes. In this construct, theories or conjectures logically precede observational data, breadth of information does not equate to depth of knowledge, and the value of a piece of information relates to its utility in changing the (highly contextual, often socially constructed) knowledge we use to make sense of something.

A more general point can be made here. Whatever philosophy is used, and CR may be built on or replaced, the important point is to be aware of its use, its limitations, its strengths and its vulnerabilities. This is important "meta-knowledge" in a sense about our own thinking.

In essence, CR and other philosophies are methodologies for thinking and reasoning; however, they say nothing about *how* to perceive the world. In this respect, an emerging area of scientific thought that offers a rich perception for contextualising the world is complex systems theory.

3.3 Complexity

In the previous section the impact of knowledge and epistemology was stressed in relation to sense making. Though philosophical models may seem irrelevant they are important and are underpinned by, and intertwined with, our understanding of the world. A particular philosophy cannot be imposed, however useful it may appear for an activity such as sense making. In this respect greater awareness of progress in an area of science called complexity theory is of value too.

In recent years this cross-disciplinary subject has opened up new understanding in many fields such as economics, biology, physics and computer science. A Complex System is any system that involves a large number of dynamically interacting elements[6]. These go through processes of change that are not describable by a single rule nor are reducible to only one level of explanation, these levels often include features whose emergence cannot be predicted from their current specifications. The field of Complexity Theory attempts to apply scientific methods to these complex systems, concentrating not on the entities but on the interactions and dynamics of the system.

The characteristics of a complex adaptive system include non-linearity, unpredictability, interdependence, dynamical behaviour and adaptation (Waldrop 1992) Many natural phenomena exhibit these behaviours such as weather systems, ecosystems such as a coral reef, and the human brain. Human systems, characterised by very large numbers of interacting agents (people) embedded in multiple, multi-directional and overlapping causal structures, are inherently complex. For instance public opinion, the motives of allies and adversaries, military operations and

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elimination; i.e., the vigorous testing of deductive consequences and the refutation of conjectures that fail...." (David Miller)

[6] A complex system is differentiated from a *complicated* system such as an aircraft that can be de-composed into a number of sub-systems with known components, relationships and function.

governmental decision-making (and the policy environment in which it occurs) are innately complex systems.

Associated with this recognition of complexity has been a mental journey for the practitioners in a variety of fields from seeing their world as ordered, relatively predictable, linear, static and based on Newtonian-type "laws" to one in which the system is inherently non-linear, unpredictable, dynamic and complex.

For decision makers sense making now involves dealing with and understanding inherently *complex,* adaptive and interlinked systems, such as social and military organisations, economies and public opinion. Cause and effect linkages are not inherently knowable in such systems, and *order* tends to be an emergent property of the system rather than a fundamental one.

Snowden identifies *ordered* and *un-ordered* domains of sense making in the Cynefin framework (Kurtz and Snowden 2003). The *ordered* domain is the realm of industrial age mental models, characterised by complicated (but not complex) systems with a definite known or knowable order, and cause and effect relations that can be studied and discovered. It is further sub-divided into empirically *knowable* (the realm of science, the expert and good practice) and *known* (the realm of bureaucracy, rules, procedures and best practice).

The Cynefin domains are shown in Table 2.

In contrast sense making in the *un-ordered* domain recognises the inherent complexity of most things and that cause and effect cannot be discovered because they are so closely intertwined. The word un-order does not mean a lack of order, it means a different kind of order, one that is in contrast to ordered-systems thinking. Ordered-systems thinking assumes that through study and analysis we can discover empirically verifiable general rules or hypotheses that create a body of reliable and enduring knowledge. The domain of un-order has the characteristics of complex, adaptive systems; here the whole is never the sum of the parts, end points are highly path dependent, and cause and effect can be made out often only in retrospect.

Applying ordered-space thinking to inherently un-ordered domains is a recipe for failure. Stewart (Stewart 2002) references the case of a group of marines taken to the New York Mercantile Exchange in 1995 to be taught and to play with simulators of the trading environment. Naturally the traders won each time. But when the traders visited the Marine Corp's base in Quantico and played war games against the marines, they won yet again. What they realized is that the traders were skilled at comprehending patterns and intervening to favourably exploit those patterns. The Marines, on the other hand, like most business school graduates, had been trained to collect and analyze data and then make rational decisions. In a dynamic and constantly changing environment, it is possible to comprehend un-order but not to assume order [7].

[7] In another experiment a group of West Point graduates were asked to manage the playtime of a kindergarten as a final year assignment. The cruel thing is that they were given time to prepare. They planned; they rationally identified objectives; they determined backup and response plans. They then tried to "order" children's play based on rational design principles, and, in consequence, achieved chaos. They then observed what teachers do. Experienced teachers allow a degree of freedom at the

Unordered Domains	**Ordered Domains**
Complex Pattern Management The domain of many possibilities: Cause and effect coherent in retrospect. Matriarchal/Patriarchal Leadership **Probe, Sense, Respond**	**Empirically knowable** Analytical/reductionist The domain of the probable. The domain of experts. Oligarchic Leadership; **Sense and Respond**
Chaos Turbulent and unconnected. Charismatic or tyrannical leadership. **Act, Sense, Respond**	**Empirically known** The domain of the actual. The only place where best practice makes sense. Bureaucracy. Feudal Leadership; **Categorise and Respond**

Table 2: Domains of Order and Un-order.

4. Discussion

ADF doctrine tends to see information and IT as crucial enablers of the so-called Revolution in Military Affairs. In contrast, our framework for sense making places knowledge (not information), and a framework for understanding how knowledge is grown and used, as the central elements. Table 3 summarises the situation, based around the three main concepts referenced in this paper – knowledge, epistemology and complexity.

Old Sense Making	**New Sense Making**
Based on 19th century physics (equilibrium, stability, deterministic dynamics)	Based on biological metaphors (structure, patterns, self-organisation, life cycle)
Philosophical underpinnings due to inductivism	Philosophical underpinnings due to critical rationality
Sees the world as orderly, predictable and well-understood	Sees the world as complex, unpredictable and poorly understood.
Knowledge can be coded, centralised and managed	Knowledge resides largely in the minds of people.
Information is key to better sense making	Knowledge is key to better sense making
Sense making occurs within a well-defined organisational hierarchy	Sense making occurs across and beyond defined organisational hierarchies
Teams actively seek confirmation of their views	Teams actively seek refutation of their views
Key enabler is networking of IT systems	Key enabler is networking of people

Table 3: Old and New Sense Making

This section discusses the some of the implications these ideas have for military decision-making, and proposes new approaches that address some of the problems identified.

start of the session, then intervene to stabilize desirable patterns and destabilize undesirable ones; and, when they are very clever, they seed the space so that the patterns they want are more likely to emerge.

4.1 Relation between sense making and decision making

For the ADF, the doctrine for the planning and conduct of operations is based on the OODA loop. In this model, sense making fits most easily into the middle Orient and Decide phases of the loop. It may be argued that the Observe (or Sense) and Act phases are performed relatively well, as our sensing abilities are at an all-time high[8], and allied actionability is similarly imposing based on equipment and training levels. The Orient and Decide phases are the most problematical for decision-makers, partly because much of the knowledge needed in these phases is tacit, and partly because the OODA approach[9] itself probably doesn't offer the best process for Commander's and their staff, particularly in complex and uncertain environments.

Bryant (Bryant 2004) has presented a new model (called CECA – Critique, Explore, Compare, Adapt) for military decision-making that better illustrates the relationships between sense making, as described here, and decision making. This model identifies an evolving and adaptive goal-directed *conceptual model* of an operation, and a *situational model* of the battlespace. Actions in this representation, in contrast with the OODA loop, are separate from CECA and are driven by the conceptual model. In addition, by placing the Critique phase at the beginning, this model brings a more critical rationalist approach to the important need to generate and refine conjectures and knowledge about the problem at hand. This model resonates with many of the ideas in this paper, and we argue that sense making fits in the middle of the CECA model as part of each of its phases, particularly the Critique stage.

In highly complex and chaotic environments, where cause-and-effect is hard if not impossible to discern (see Table 2), the Commander and his force attempt to *create* rather than *discover* the future. Again the CECA model, with its idea of working towards *end-states* (or advantageous points of some stability), seems to encompass this idea more readily than OODA[10] where *actions* are the main output of decision-making.

4.2 Implications from a scientific approach to thinking

From a sense making perspective the CR philosophy has a number of potential benefits as a methodology for knowledge development. It could potentially serve as the foundation of a more open and effective decision-making and sense making process where:

- We actively look for evidence that does not fit with our conjectures;
- We attempt to make our reasoning and thinking processes rational and open to critical conjecture;

[8] One instance of this is the success of blue-force tracking (BFT) systems in the current Iraq conflict.
[9] As pointed by Giffin and Reid (Giffin and Reid 2003) and Bryant, OODA has a number of fundamental flaws as a decision-making doctrine. Primary among these are an inductivist approach to knowledge growth that appears to start with observation and data collection before orientation and understanding.
[10] OODA may be a very useful approach in highly tactical situations (such as for Pilots in a dog-fight), where uncertainties and complexities are largely in a constrained physical domain, and where the conceptual model of the engagement is easily articulated and shared.

- New information can be assessed appropriately - as messages that can impact or alter the knowledge and understanding of the sense maker(s);

This is an open framework for discovering and evaluating new and unexpected things, and as such can be viewed as a learning strategy for the ADO intelligence enterprise. Some of the consequences of a successful implementation of this strategy are that:

- Intelligence processed in this way is presented to the decision-maker with a plausible understanding of a complex environment represented through a range of partially supported conjectures;
- The decision maker can avoid early closure based on initial evidence;
- We have a more organic method for dealing with fleeting opportunities and unforseen threats.

The foundational aspects of knowledge development also have implications for the collaborative networks they are a part of. This is summarised in the next section.

4.3 Support for knowledge creation

Key to supporting creative thinking is providing opportunities, structures and technology that allow staff to interact with each other, sharing their underlying theories and ideas and examining and testing out each other theories and ideas.

To do this requires an environment where different views are encouraged, and exploited to produce full, multifaceted analysis. In such an environment there are organisational structures that support collaboration across group and organisational boundaries[11].

In this respect there are two important types of collaborative networks:

Community of Practice. The *Community of Practice* (CoP) is centred on a well-defined domain of knowledge and expertise; it taps into *depth* of specialist knowledge reflecting an environment of 'conventional wisdom'. The members of the community share a common set of patterns of interpretation, implicit assumptions, and beliefs. The goal of the community is to create, maintain, and share its knowledge within a well-defined domain. These communities can be informal or formally structured, and are typically long-lived in comparison to task or team oriented groupings. All members can equally share the community's knowledge, and equally add to the community's knowledge through their work and experiences. These kinds of communities also perform the role of enculturation new members into the knowledge of the community – passing on the facts, methods, information, the lore, the language, and the ways of thinking that are a part of the community (Wenger 1998). This can be seen as an ordered domain process that incrementally grows and maintains

[11] These communities are supported by technology such as:
Basic tools to support collaboration across time and space are available. These include communications tools (e-mail, instant messaging and so on), as well as tools to support sharing and collaboration of information); and
Tools and processes that allow individuals to discover each other, and to build working relationships with each other.

knowledge. It roughly maps on to the top right of the sense making domains of Table 2.

Exploration Network. Increasingly important, this relates to the formation of new patterns of perceptions, new ways of understanding the world, the disruption of existing beliefs and ultimately innovation across the entire enterprise. In effect it seeks to tap into *breadth* of knowledge to create an environment encouraging counter-intuitive insight. We coined the term *exploration networks* to connote the organisational unit in which this process can occur. Today these are recognisable as informal groupings of friends, associates and colleagues drawn from inside and outside the functional groupings of task and organisation. Membership to these kinds of communities is loosely defined, with members having similar or very different patterns of interpretation, assumptions, and beliefs. Potentially these networks can work at the edges of what is known where existing patterns of interpretation, implicit assumptions, and beliefs fail. We argue that these networks need to be recognised, cultivated and exploited by the intelligence enterprise. The exploration network grows new patterns of perception that may be exploited within the rest of the intelligence community, and roughly maps onto the top left of Table 2.

These networks are compared and contrasted in Table 4. As indicated in Table 4 these networks serve different purposes and have different sense making methodologies and approaches. For the decision maker the CoP helps to maintain and build deep knowledge in a particular area or domain. In an Intelligence Preparation for the Battlespace process for example, intelligence analysts who specialise in various areas of the operational area provide the deep knowledge. The exploration network in contrast is designed to generate new conjectures and confront existing ideas and conceptualisations.

Community of Practice	**Exploration Network**
Specialised terminology	Everyday language
High levels of abstraction	Low levels of abstraction
Shared practice and domain of interest	Shared experiences, values and beliefs.
Well-defined practice within the domain – the set of frameworks, tools, information, language and documents that the community shares.	The development of a practice is a possible, long-term outcome of exploration, not a given.
Well-defined areas of common interest (the domain of the CoP)	Often poorly defined areas of common interest
Long-lived, relatively static membership	Short-lived, dynamic associations
Community members defined by professional or organisational groupings	Networks form and re-form depending on task and need
Goal is incremental improvement in applying knowledge in a well-defined area	Goal is to develop new interpretations, conjectures, ideas and ways of looking at the world that may be exploited for a purpose
Examples include guilds, scientists within a field, technical repair staff, software engineers, and intelligence experts in a particular field	Examples include heterogeneous work units such as Tiger Teams, and social networks such as Community Action Groups

Table 4: Community of Practice and Exploration Network characteristics

4.4 Implications for operational planning

Table 5 is used in the following as a means of discussing some of the concepts in this paper with reference to the planning and conduct of ADF operations.

The table shows a highly abstracted ADF planning and operational lifecycle with phases varying from long term and strategic to short term and tactical. We have indicated sense making occurring at each level of the lifecycle. And, and with reference to Figure 1, at each level the *context* – including the goals, constraints and time scales - surrounding the process is different. Similarly, the *knowledge* brought to the process and the *information* that is relevant varies according to the level. Sense making for this table is as described in this document – it relates to complex, dynamic and uncertain, and in some cases unknowable entities, it should be viewed within a Popperian enquiring system, the knowledge that participants bring to it is crucial, and the inherent complexity of the subjects under discussion must be taken into account.

	Outputs	**Principal Actors**	**Constraints**	**Time scale**	**Exploration network**	**Sense making context**
Long term strategic P0	White papers; AIPs;	Government Mil strategy	Government policy; Expectations of allies;	Long (years)	Strategic intelligence; Whole-of-government reps; Principal actors;	Emerging threats; Government policy; Understanding of national and political effects of force;
Deliberate Planning P1	Plans	Mil strategy; Mil op;	Existing capability; Government policy; AIPs;	Medium (weeks, months)	Strategic intel; Operational intelligence; Principal actors;	Military appreciation; Understanding of broader effects of operation;
Immediate Planning P2	Plans; Orders; CONOPs	Mil op; Mil str; Government Coalition partners	Commanders intent; Time for planning; ROE; Capability; Preparedness;	Short (weeks, days)	Strategic intelligence; Operational intelligence; HUMINT; Principal actors;	Military appreciation; Understanding of broader effects of operation;
Conduct of Operation P3	FRAGOs Briefs; SITREPs;	Mil op; Components Coalition partners;	Orders; Time for deployment; ROE; Equipment;	Short (weeks, days, hours)	Strategic intelligence; Operational intelligence; HUMINT; Principal actors;	Understanding commander's intent; Local situation; Understanding conceptual model of networked decision-makers;

Table 5: Sense making for planning life cycle (highly abstracted)

The headings, and their contents, are intended to be a précis, and broadly indicative rather than exhaustive, of the important elements in the planning process. By explicitly considering sense making[12] at each phase of this process we are led to consider how sense and understanding is transferred between levels, in both

[12] Many, and perhaps the bulk, of the activities associated with these phases do not involve sense making.

directions. This in turn leads to a view of sense making as an enabler of a learning[13] mechanism for the ADF, in which insights at one level are interpreted, transformed and used at other levels for the ultimate goal of better conduct of future operations.

Each level inherits, to a greater or lesser degree, the decisions of the previous one. So by the time an operation is being conducted long-term decisions made about military capability, and the decisions made in the planning of the operation including the Commander's intent, the equipment and personnel being used and so on, impact heavily on that phase. Less apparent than these decisions are the constituents of the sense making process that arrived at them. It is on this area that we'd like to focus discussion.

We contend that much of the core knowledge for sense making is tacit, and finding means for communicating this is vital. Approaches that assist in this tacit to explicit knowledge conversion are techniques and technologies for socialisation of ideas such as:

- Creative dialogue, brainstorming.
- War gaming and what-if scenario examination.
- Synchronous technologies that link distributed teams such as video- and tele-conferencing

While these techniques are currently employed for the ADF, we argue that greater emphasis and greater awareness needs to be placed on generating, exploring and refining the conjectures that underpin operations. The Exploration Network, described in Section 4.2, is one approach that may assist in this regard.

The Exploration Network column in Table 5 indicates the members of a community that have a wide variety of world-views and mental models and engage in creative thinking about a complex domain. The entries are very broadly indicative of the types of people that might be useful to have involved in these networks. In helping to refine plans, goals and intents these networks will support the existing deep knowledge and expertise possessed by military planners and strategists. The role of the latter is more akin to a Community of Practice described in the previous section.

In addition to the creative and exploratory role already outlined we might see an additional role for some of the Principal Actors or Exploration Network members as mediators or brokers of knowledge between phases. This is a human-mediated approach to the problem of knowledge transference between distributed (in time and space) decision-makers with different roles and responsibilities.

It may be argued that these networks are already in use, albeit without explicitly being recognised as such. Bryant's [ref] reference to the "directed telescope" of Van Creveld points out an instance of knowledge brokering between levels that sounds

[13] Learning in this context is considered different to teaching. The latter is imparting knowledge, based on experience and expertise, about what is (assumed to be) already very clearly known and understood. It is often based around policy, procedures and doctrine and the much of the knowledge exists in explicit form. Learning is a precursor to teaching. Here much of the knowledge is tacit, and learning occurs in uncertain and novel environments where there are no road-maps, where existing experience and expertise is lacking, and where real innovation and understanding is important for survival.

somewhat similar to what we are proposing here. We are attempting to generalise that concept and provide a sound basis for understanding their role in sense making.

4.5 Issues

There are practical issues and uncertainties associated with implementation of the sense making ideas proposed here for decision-making and command and control.

1. If, as we argue, much of the key knowledge – the insights, conjectures, hunches, assumptions - for sense making is tacit, how much of this can be usefully communicated to others? Asynchronous communication across multi-national, distributed forces is the most difficult scenario. Cultural differences, trust and mechanisms for agreement then become major factors.

2. And more fundamentally in what situations is it necessary to communicate these understandings? Communicating the explicit products of sense making and decision-making (orders, briefs, etc) is, relatively speaking, much easier and may be sufficient for some needs. Is it possible to identify archetypal operational scenarios where understanding and awareness must be conveyed by person-to-person interactions, and those in which the situation is sufficiently well understood that ultimately automated or machine-mediated decisions can be taken?

3. How do we reconcile the conflicting demands of operational security on the one hand, and left-field counter-intuitive creative insight provided by exploration networks made up of diverse actors on the other?

There is a need for experimentation here to scope out these issues and provide some guidance for the way ahead. A major vehicle for experimentation could be based around different decision-making doctrines such as OODA and CECA. This could be explored in a war-gaming environment, and may give an experimental framework for quantifying the value of conjectures formed by different approaches to sense making, and the flow of information and knowledge that supports them.

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References

ADFWC (2003). Australian Future Warfighting Concept.

Bryant, D. J. (2004). Moderninzing our Cognitive Model. Command and Control Research and Technology Symposium, San Diego, CA, CCRP.

Burnett, M., Wooding P and Prekop, P (2004). Sense making in the ADO intelligence enterprise, DSTO discussion paper (in publication).

Davenport, T. H. and L. Prusak (1997). *Working Knowledge: How Organizations Manage What They Know*, Harvard Business School Press.

Endsley, M. (1995). Toward a theory of situation awareness in dynamic systems, Human Factors, 37(1), 32-64

Firestone, J. M. and M. W. McElroy (2003). Corporate Epistemology: Competing Philosophies of Truth in Business And How They Influence Knowledge Management, Executive Information Systems.

Giffin, R. E. (2002). Naïve Inductivism in Command and Control Doctrine:Its Causes, Consequences and Cures. 7th International Command and Control Research Symposium, Quebec City, C4ISR Cooperative Research Program (CCRP), Washington, D.C. USA.

Giffin, R. E. and D. J. Reid (2003) (I). A WOVEN WEB OF GUESSES, CANTO ONE: Network Centric Warfare and the Myth of the New Economy. 8th International Command and Control Research Symposium, Washington, D.C., C4ISR Cooperative Research Program (CCRP), Washington, D.C. USA.

Giffin, R. E. and D. J. Reid (2003) (II). A WOVEN WEB OF GUESSES, CANTO TWO: Network Centric Warfare and the Myth of Inductivism. 8th International Command and Control Research Symposium, Washington, D.C., C4ISR Cooperative Research Program (CCRP), Washington, D.C. USA.

Hayes, R. M. (1993). "*Measurement of Information*." Information Processing and Management **29**(1): 1-11.

Kurtz, C. F. and D. J. Snowden (2003). "*The new dynamics of strategy: Sense-making in a complex and complicated world*." IBM Systems Journal **42**(3).

McDermott, R. (1999). "*Learning Across Teams: How to build communities of practice in team organisations*." Knowledge Management Review **May/June**(8).

Nitecki, J. (1985). "*The concept of information-knowledge continuum: implications for librarianship*." Journal of Library History **20**(4): 387-407.

O'Connell, D. (1998). "Book Review of Sensemaking in Organizations." Administrative Science Quarterly,.

Polanyi, M. (1966). *The Tacit Dimension*. London, Routledge & Kegan Paul Ltd.

Popper, K. (2002). The Logic of Scientific Discovery. London, Routledge.

Reid, D. J. and R. E. Giffin (2003). A WOVEN WEB OF GUESSES, CANTO THREE: Network Centric Warfare and the Virtuous Revolution. 8th International Command and Control Research Symposium, Washington, D.C., C4ISR Cooperative Research Program (CCRP), Washington, D.C. USA.

Snowden, D. (2002). "*Complex acts of knowing: paradox and descriptive self-awareness*." Journal of Knowledge Management **6**(2).

Stacey, R. D. (1992). *Managing the Unknowable : Strategic Boundaries Between Order and Chaos in Organizations*, Jossey-Bass.

Stewart, T. A. (2002). *How To Think With Your Gut*. Business 2.0.

Waldrop, M. (1992). Complexity: The Emerging Science at the Edge of Order and Chaos, Simon & Schuster.

Weick, K. E. (1995). Sensemaking in Organizations, Sage Publications.

Wenger, E. (1998). "*Communities of Practice: Learning as A Social System*." Systems Thinker.